UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue
Seattle, WA 98101

Fact Sheet

RBM-10 Water Temperature Model

July 20, 2001

Introduction

RBM-10 is a one-dimensional mathematical model of the thermal energy budget of water bodies that simulates daily or hourly average water temperature under conditions of gradually varied flow. Models of this type have been used to assess water temperature in the Columbia River system for a number of important environmental analyses. The Federal Water Pollution Control Administration (Yearsley, 1969) developed and applied a one-dimensional thermal energy budget model to the Columbia River as part of the Columbia River Thermal Effects Study. The Bonneville Power Administration et al. (1994) used HEC-5Q, a one-dimensional water quality model, to provide the temperature assessment for the System Operation Review, and Normandeau Associates (1999) used a one-dimensional model to assess water quality conditions in the Lower Snake River for the U.S. Army Corps of Engineers.

Information needs

General

- system topology;
- latitude of the site;
- day of the year;

River Geometry

- the cross-sectional area of the river;
- the width of the river;
- river mile;

Mainstem

- boundary inflows;
- boundary temperatures

Tributary

- tributary and point source flows;
- tributary and point source temperatures;

Weather

- cloud cover;
- dry bulb air temperature;
- wind speed;
- vapor pressure of the air near the water surface;
- atmospheric pressure.

Available Information

No. of field stations or measurements for the required information:

Tributary Temp	River Geometry	Hydrology (USGS)	Weather
19 discon-tinuous 30 year record	Existing 99 Dams removed 117	22 contin-uous 30 year record	5 contin-uous 30 year record

Modeling Challenges

- Limited number of weather stations;
- No temperature and flow data for the rivers without dams;
- Discontinuous data record for tributary temperatures.

Modeling Advantages

- 30 years continuous weather data;
- 30 years continuous tributary and mainstem flow data;
- 30 years of mainstem temperature data.

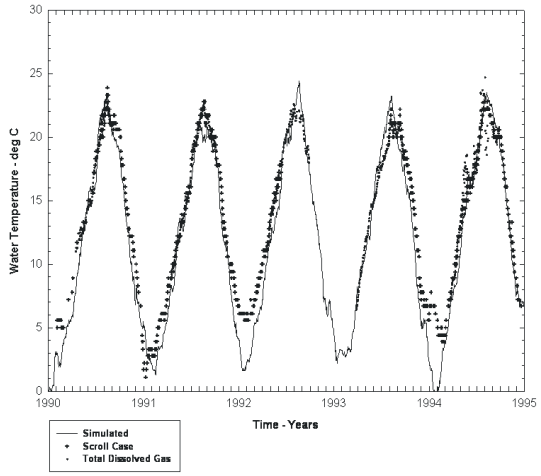
Model Considerations

The RBM-10 model output is the cross sectional average temperature of the river at any place along the river length. This is the appropriate model output given the input data limitations. RBM-10 has been designed to quantify and account for uncertainty due to data limitations, measurement errors, etc. An understanding of model uncertainty is important for making policy decisions and other uses of the model.

Other models can simulate instantaneous temperature at specific places in the river cross section (instead of hourly or daily cross sectional averages). Given the data limitations, there would be a great deal of uncertainty associated with these simulations and no way to quantify the uncertainty.

Evaluation of the Model

The following figure is an example of a simulation of temperature at Bonneville Dam, the last dam on the river. The continuous line represents the model result, while the dots represent actual temperature measurements from Bonneville Dam.



Simulated and observed water temperatures at Bonneville Dam for the period 1990–1994.

Regressions of observed versus simulated temperatures were run for all the dam locations. The correlation coefficients ranged from 0.9035 to 0.9725. The coefficient for the data shown is 0.9035. The results shown here are suitable for input to policy and management decisions. We cannot do a similar analysis for natural temperature conditions because there is no data record for natural temperatures.

Further Information

The entire model, all the temperature data used, user friendly interfaces for running the model and the following technical report are included on a CD that can be obtained from EPA.